Changes in Turkey Intestinal Tract Bacteria Associated with Dietary Change from Monensin to Bacitracin, Virginiamycin, or Bambermycin

S. E. CRAVEN[1], N. A. COX, M. E. BERRANG, and N. J. STERN
USDA, Agricultural Research Service, Russell Research Center,
Poultry Microbiological Safety Research Unit, P.O.Box 5677,
Athens, GA 30604-5677
Phone: (706) 546-3986
FAX: (706) 546-3772
e-mail: scraven@saa.ars.usda.gov

T. S. CUMMINGS
Poultry Business Team, Pfizer Animal Health, HC69, Box 984,
White Sulphur Springs, WV 24986

Primary Audience: Production Managers, Quality Control Personnel, Researchers

Summary

In a field trial involving commercial turkeys whose feed was changed at 77 d of age from one containing monensin to one containing bacitracin, the intestinal counts for total aerobic bacteria, enterobacteriaceae, lactobacilli, total anaerobic bacteria, and clostridia were similar at flock ages of 28 to 91 d. At 109 to 120 d, the numbers of lactobacilli and clostridia, but not of the other bacterial groups, were higher. In another trial, turkeys were maintained on feed with monensin until the age of 56 d. They were then given feed containing no antimicrobial, monensin as before, or a growth-promoting antibiotic: virginiamycin, bambermycin (Flavomycin), or bacitracin. Bacterial numbers in the intestinal contents of birds killed 1 d before and 1, 3, 7, or 16 d after the change varied with bacterial group, intestinal site, and time after feed change. These changes were transient and not widespread. The numbers for each bacterial group were similar in birds given feed containing the growth-promoting antibiotics.

Key words: Clostridia, enterobacteriaceae, growth-promoting antibiotics, lactobacilli, monensin, total aerobic bacteria, total anaerobic bacteria, turkey feed

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Description of Problem

Antibiotics are used in animal production for a variety of purposes, including therapy, disease prevention, and production enhancement [1]. Addition of certain antibiotics to feed at subtherapeutic levels for an extended period of time is a common practice of the poultry industry and provides economic benefit by increasing weight gain, improving feed efficiency, or modifying some other production parameter. Antibiotics are thought to promote improved growth re-

[1] To whom correspondence should be addressed.

sponses by affecting the autochthonous microflora in the gastrointestinal tract [2]. Results of studies comparing the growth responses of conventional and germ-free chickens support this view [3, 4]. Conventional chickens fed antibiotics exhibit growth and feed efficiencies approaching those achieved by germ-free chickens. Those intestinal organisms associated with reduced growth of the animal or that are inhibited by these antibacterial agents have not been conclusively identified. Results of some experiments provide evidence for *Clostridium perfringens* as a causative agent for growth depression [5]. Other studies have failed to demonstrate significant change in the microbial composition of the intestinal tract when antibiotics are fed to animals [6, 7].

A change in feed additive from an anticoccidial to a growth-promoting antibiotic is a normal management practice in commercial turkey production that must comply with FDA combination clearances. Little is known about the effect of a change in feed antibiotics on the intestinal microflora and shedding of bacteria in turkeys. A better understanding of the factors contributing to improved weight gain/feed efficiency and any associated changes in intestinal microflora from use of growth-promoting antibiotics could provide information to guide their efficacious and judicious use. The purpose of this study was to investigate the changes in populations of native intestinal bacteria in turkeys, following the industry practice of changing from feed containing an anticoccidial to one containing a growth-promoting antibiotic.

Materials and Methods

FIELD TRIAL (TRIAL 1)

In September 1997, 15 turkeys from each of four different age groups (total 60, predominantly male) were obtained from farms of a nearby producer and were transported live to the State Veterinary Lab in Monroe, NC. The age groups were 1) 28 to 30 d from four farms, 2) 55 to 56 d from two farms, 3) 80 to 91 d from two farms, and 4) 109 to 120 d from two farms. The turkeys from these farms were maintained on a basal feed containing an anticoccidial, monensin [8]. For these birds, the producer replaced the feed containing monensin with feed containing bacitracin [9] at 77 d of age. Consequently, the first two age groups included turkeys receiving feed containing monensin, and the other two age groups were receiving feed with bacitracin. Birds from the different age groups were transported to Monroe, NC, and were killed. The intestinal tract was removed, and the contents of selected sections of the jejunum or cecum were processed on site to determine bacterial populations. Each intestinal sample was processed to include mucosal and luminal components. After the plates of bacteriological media containing dilutions of the intestinal contents were prepared, they were transported anaerobically to the lab in Athens, GA, and incubated at 37°C as described in the floor-pen trial procedure.

FLOOR-PEN TRIAL (TRIAL 2)

A total of 150, 35-d-old female turkeys from a South Carolina producer was transported to Athens, GA. Five groups of 30 randomly selected birds were placed in separate environmentally controlled, isolator floor pens (8 ft × 8 ft) and provided feed ad libitum that was similar to the commercial feed previously given to them (corn/soy-based ration with 72 g monensin/ton). Environmentally controlled floor pens were monitored twice daily to ensure that all birds were exposed to similar environmental conditions. The birds were maintained on the feed with monensin for 21 d to allow adjustment to their new housing. After this period, all feed was removed from the five floor pens and replaced with one of five different feed treatments: 1) basal feed without monensin or antibiotics, 2) as before, basal feed with 72 g monensin/ton [8], 3) basal feed with 20 g virginiamycin/ton [10], 4) basal feed with 2 g bambermycin (Flavomycin) ton [11] and 5) basal feed with 50 g bacitracin/ton [9]. Each group of birds was maintained on one of the five feed preparations for another 16 d. At 1 d before feed change and at 1, 3, 7, and 16 d after feed change, five turkeys from each feed treatment were killed, and the contents of the jejunum and cecum were sampled, as described for the field trial.

MICROBIOLOGICAL METHODS

For determination of bacterial counts, sections of similar length were cut from each intesti-

nal portion sampled and were placed in Stomacher bags. Cary-Blair medium was added to give an initial dilution of 1:5, and the intestinal sections were macerated in the Stomacher lab blender [12]. Subsequent dilutions were prepared in Cary-Blair medium, and aliquots were spread onto the surfaces of the plating media. The bacteriological plating media used included plate count agar [13] for total aerobic bacteria; violet red bile agar (VRBA) [14] for enterobacteriaceae; MRS agar [14] for lactobacilli; brain-heart infusion agar (BHI) [15] for total anaerobic bacteria; and clostrisel agar [14] for clostridia. BHI and clostrisel agars were prepared as prereduced anaerobically sterilized (PRAS) media. For the field trial, PRAS media were prepared according to the procedure of Holdeman and Moore [16]. For the floor pen trial, PRAS media were prepared using oxyrase pre- and postconditioners [17].

After preparation, plates of PRAS media were placed in oxygen-impermeable plastic bags [18] with anaerobic sachets and indicators [13]; the air was evacuated by drawing a partial vacuum and was replaced twice with a 95% nitrogen, 5% hydrogen mixture using the Multivac vacuum sealer Model A300/16 [19]. After processing the intestinal portions, samples plated on PRAS media were placed in the oxygen-impermeable bags as described previously. Plates were incubated at 37°C as follows: VRBA and plate count agars were incubated aerobically for 24 h, MRS agar in air containing 5% CO_2 for 72 h, BHI and clostrisel agars anaerobically (as previously described), for 48 h. After incubation of plates, colonies were counted, and results were converted to colony-forming units per gram of intestinal material.

STATISTICAL ANALYSES

Data were analyzed using PROC GLM of SAS software [20]. The design of the field trial was a split-split-plot experiment with ages as main plots, intestinal portions as subplots, and bacterial types as sub-subplots. The design of the floor pen trial was a split-split-split-plot experiment with feed treatments as the main plots, ages as subplots, intestinal portions as sub-subplots, and bacterial types as sub-sub-subplots. Significance was determined at $P < 0.05$.

Results and Discussion

A preliminary trial was used to evaluate sampling methodology for autochthonous intestinal bacteria of turkeys. Sampling recently killed turkeys on site, in the field, and without access to an anaerobic glove box was superior to sampling that involved a 3-h shipment of intact intestinal sections in sealed plastic bags on ice for processing in the anaerobic glove box located at the research facility. The total anaerobic bacterial and clostridial counts were 1.6 to 3.5 log factors lower for those samples shipped on ice.

In the field trial (Trial 1), some differences were observed when comparing counts in the jejunum to corresponding counts in the cecum (Table 1). For the enterobacteriaceae, the counts in the jejunum were lower but not significantly different than those in the cecum. For the total aerobic bacteria, lactobacilli, total anaerobic bacteria and clostridia counts in the cecum were significantly higher than corresponding counts in the jejunum.

For the most part, the counts for each bacterial group from each of the intestinal portions were similar throughout growout with no increases or decreases in numbers before or after the change in feed antimicrobials at 77 d. Counts were similar for a particular bacterial group in a given intestinal portion when comparing the counts at 28 to 30, 55 to 56, and 80 to 91 d of age. By 109 to 120 d, counts were similar to those at 28 to 91 d for all bacterial groups, except the lactobacilli and clostridia. Lactobacilli counts were significantly higher (by 1.7 to 2.2 logs) in the jejunum and the cecum at 109 to 120 d as compared to 80 to 91 d. Clostridial counts were significantly higher (by 2.1 to 2.7 logs) at 109 to 120 d in the jejunum but were similar in the cecum from 28 to 120 d.

The second trial was conducted in floor pens under controlled environmental conditions and was designed to determine changes in bacterial populations during the first 16 d following a change from feed containing an anticoccidial to one containing a growth-promoting antibiotic (virginiamycin, Flavomycin, or bacitracin).

In evaluating the effects of the change in feed formulations with respect to antimicrobial additives, counts from birds given feed containing one of the three antibiotics (Treatments

TABLE 1. Microbial counts (cfu/g intestinal material ± SD) of bacterial populations from the intestinal tract of commercial turkeys, Trial 1

		AGE OF TURKEYS (Days)[A]			
BACTERIAL GROUP	INTESTINAL PORTION	28–30	55–56	80–91	109–120
Total aerobes	Jejunum	5.4 ± 0.9[b]	5.5 ± 1.0	4.9 ± 1.2[ab]	6.0 ± 1.6[ab]
	Cecum	7.1 ± 0.7[a]	6.5 ± 0.8	7.0 ± 1.1[a]	7.4 ± 0.5[a]
Enterics[B]	Jejunum	4.2 ± 1.7	4.9 ± 1.7	3.9 ± 1.5	5.1 ± 1.2
	Cecum	6.6 ± 0.7	6.0 ± 0.9	5.6 ± 1.1	5.8 ± 0.9
Lactobacilli	Jejunum	3.7 ± 1.2[bz]	4.7 ± 1.2[byz]	4.9 ± 1.3[yz]	6.6 ± 1.6[y]
	Cecum	7.1 ± 0.4[ayz]	7.0 ± 0.4[ayz]	5.4 ± 1.5[z]	7.6 ± 0.5[y]
Total anaerobes	Jejunum	6.9 ± 1.2[b]	6.5 ± 1.4[b]	7.0 ± 1.2[b]	7.6 ± 1.7
	Cecum	9.5 ± 0.4[a]	9.7 ± 0.9[a]	9.6 ± 0.9[a]	8.4 ± 1.3
Clostridia	Jejunum	5.6 ± 0.8[byz]	4.7 ± 0.2[bz]	4.9 ± 0.5[byz]	7.0 ± 1.7[y]
	Cecum	7.9 ± 1.0[a]	7.6 ± 2.4[a]	7.6 ± 1.5[a]	7.8 ± 1.2

[A]Birds were maintained on feed containing monensin (anticoccidial) until 77 d of age. At that time they were switched to feed containing the growth promotant BMD (bacitracin) but containing no anticoccidial and were maintained on that feed until the end of the trial (120 d).
[B]Enterobacteriaceae.
[a,b] For a given bacterial group, values in a column with different lowercase letters are significantly different ($P < 0.05$).
[y,z]Values in a row with different lowercase letters are significantly different ($P < 0.05$).

3 to 5) were compared to counts from birds that continued to receive monensin (Treatment 2). Bacterial counts in the jejunum were similar when comparing the birds in different floor pens 1 d before the feed was changed (Table 2). After the feed change, few differences in counts were observed in the jejunum when comparing those in birds kept on feed with monensin to those in birds changed to feed containing one of the three growth promotants. When differences did occur, they were less than 1.5 log factors and were observed on one sampling day only.

In the cecum, few differences were observed in bacterial counts of birds switched to feed containing one of three growth promotants compared to those kept on monensin (Table 3). Differences, when noted, occurred on only one of five sampling days.

In the floor-pen trial, the removal of monensin had little effect on counts of bacteria in the jejunum or cecum (Tables 2 to 3). The counts of enterobacteriaceae in birds receiving feed with no monensin and no growth-promoting antibiotic (Treatment 1) were sometimes lower than counts in birds left on monensin (Treatment 2), but differences were again transient (i.e., occurring on only one sampling day) and limited (i.e., in only one portion of the intestinal tract).

Some general conclusions can be drawn from the results of the field and floor-pen trials. The highest overall bacterial counts were found in the ceca of turkeys. The total anaerobic count > lactobacilli/clostridia > total aerobic count > enterobacteriaceae.

The three growth-promoting antibiotics used in this study and some others act primarily against the Gram-positive bacteria such as the lactobacilli and *Clostridium* spp. Although monensin is added to feed primarily to prevent the development of coccidiosis in birds, it also has antibacterial activity, particularly against the Gram-positive *Clostridium* spp. [21]. For the most part, changing from monensin to one of the three antibiotics had no significant effect on bacterial populations in the intestinal portions sampled. The changes in counts of certain bacterial groups after the removal of monensin and addition of the growth-promoting antibiotics such as virginiamycin, Flavomycin, or bacitracin were transient.

Our results are similar to those reported by others for chicks [22, 23], wherein high numbers of clostridia and lactobacilli were found in the chick small intestine and ceca. In the field trial (Trial 1) and floor-pen trial (Trial 2), the lactobacilli and clostridia populations were the most variable after the change to feed containing these antibiotics. In the floor-pen trial, transient decreases for the two bacterial groups were observed 7 d after the change from monensin to virginiamycin, Flavomycin, or bacitracin when birds were 63 d of age. In the field trial, an increase in population of these bacteria was ob-

served in the jejunum or cecum of birds 35 d after a change from monensin to bacitracin and when birds were 100 to 120 d of age.

Results in the floor-pen trial do not support a conclusion that these increases observed in the field trial are due to the change in feed antimicrobials. However, neither do they disprove it, because the final samples in the field trial were taken 35 d after the change in feed as compared to 16 d after the change in feed in the floor-pen trial. Changes could occur between 16 and 35 d after feed change or in direct response to bird age [24]. The increases in counts of lactobacilli and clostridia in the field trial at 100 to 120 d could be due to change in antimicrobials, bird age, experimental variation, or some other factor. This study would not necessarily have detected major population changes in certain bacterial species, because only certain bacterial groups, each including many bacterial species, were enumerated.

Subtherapeutic levels of antibiotics can also affect the synthesis of surface organelles of bacteria without changing cell numbers [25] or affect microbial enzyme activity in the poultry intestine [2]. Such changes could influence the ecology of the turkey gut. Additional research will be needed to determine whether increases in these bacterial populations in turkeys aged 109 to 120 d occur consistently and, if so, whether they are related to previous changes in feed antimicrobials.

TABLE 2. Microbial counts of bacterial populations from the jejunum of commercial turkeys for up to 16 d after a change in antimicrobial feed treatment, Trial 2

BACTERIAL GROUP	ANTIMICROBIAL IN FEED AFTER CHANGE[A]	CONTENTS OF JEJUNUM (mean $\log_{10}$ cfu/g ± SD)[B]					OVERALL MEAN[B]
		0	1	3	7	16	
Total aerobes	None	5.7 ± 1.0	5.6 ± 0.9	5.8 ± 0.7	4.5 ± 0.7	4.7 ± 0.5^{ab}	5.3
	Monensin	5.4 ± 1.0	5.5 ± 0.1	5.2 ± 0.3	5.8 ± 0.5	5.2 ± 0.7^{ab}	5.4
	Virginiamycin	4.8 ± 0.9	5.8 ± 0.5	5.7 ± 0.6	6.0 ± 0.8	5.4 ± 0.4^{a}	5.5
	Flavomycin	4.9 ± 0.9	4.8 ± 0.6	4.9 ± 0.5	5.8 ± 0.5	4.9 ± 1.1^{ab}	5.1
	Bacitracin	4.3 ± 0.6	5.5 ± 0.7	5.7 ± 0.5	5.7 ± 0.7	4.1 ± 0.7^{b}	5.1
Enterics[C]	None	4.7 ± 1.2	3.4 ± 1.2^{b}	4.9 ± 1.5^{ab}	3.6 ± 1.4^{b}	3.0 ± 1.0	3.9
	Monensin	5.1 ± 0.6	5.2 ± 0.6^{b}	4.0 ± 0.7^{ab}	5.6 ± 0.5^{ab}	4.5 ± 1.0	4.9
	Virginiamycin	4.4 ± 0.8	6.4 ± 0.3^{a}	5.1 ± 1.0^{a}	5.8 ± 0.7^{a}	3.8 ± 1.0	5.1
	Flavomycin	5.1 ± 1.2	4.4 ± 1.5^{b}	4.9 ± 1.5^{ab}	5.8 ± 0.6^{a}	3.4 ± 1.4	4.7
	Bacitracin	4.8 ± 1.0	5.2 ± 1.0^{ab}	3.1 ± 0.9^{b}	5.5 ± 0.5^{ab}	3.1 ± 1.1	4.3
Lactobacilli	None	4.7 ± 0.4	6.7 ± 0.2	5.9 ± 0.1^{a}	3.9 ± 0.5^{b}	4.7 ± 0.6	5.2
	Monensin	4.7 ± 0.7	6.5 ± 0.6	5.6 ± 0.3^{ab}	6.4 ± 0.5^{a}	4.7 ± 0.6	5.6
	Virginiamycin	4.2 ± 0.9	6.8 ± 0.3	5.8 ± 0.2^{ab}	6.3 ± 0.2^{a}	5.0 ± 0.9	5.6
	Flavomycin	4.6 ± 0.6	6.3 ± 0.4	5.7 ± 0.1^{ab}	6.3 ± 0.8^{a}	5.2 ± 1.2	5.6
	Bacitracin	4.8 ± 1.6	6.5 ± 0.4	5.5 ± 0.2^{b}	6.3 ± 0.5^{a}	3.8 ± 0.6	5.4
Total anaerobes	None	7.9 ± 0.8^{a}	8.3 ± 0.9	6.6 ± 0.6	7.0 ± 0.8	6.3 ± 1.2	7.2
	Monensin	6.5 ± 0.7^{ab}	7.7 ± 1.3	6.1 ± 0.4	6.6 ± 0.5	6.7 ± 1.1	6.7
	Virginiamycin	5.6 ± 0.3^{b}	8.6 ± 1.4	6.7 ± 0.4	6.3 ± 0.5	6.2 ± 1.1	6.7
	Flavomycin	6.4 ± 0.9^{ab}	9.2 ± 0.2	6.7 ± 0.3	6.5 ± 0.6	6.2 ± 0.6	7.0
	Bacitracin	6.0 ± 0.6^{ab}	9.4 ± 0.5	6.2 ± 0.6	6.5 ± 0.8	6.0 ± 1.0	6.8
Clostridia	None	4.5 ± 1.1	4.5 ± 1.3^{ab}	4.9 ± 0.9	4.7 ± 0.7	4.6 ± 1.1^{ab}	4.6
	Monensin	3.9 ± 0.4	4.1 ± 0.3^{b}	4.4 ± 0.5	5.6 ± 0.7	4.9 ± 0.5^{a}	4.6
	Virginiamycin	3.8 ± 0.3	5.5 ± 0.6^{a}	4.5 ± 1.0	4.6 ± 0.4	4.3 ± 0.7^{ab}	4.5
	Flavomycin	3.6 ± 0.4	4.6 ± 0.6^{ab}	3.7 ± 0.9	5.4 ± 0.4	3.7 ± 0.5^{ab}	4.2
	Bacitracin	4.2 ± 1.2	4.9 ± 1.2^{ab}	4.1 ± 0.7	5.3 ± 0.5	3.6 ± 0.7^{b}	4.4

[A]Turkeys that were 5 wk old and on feed with monensin (anticoccidial) were obtained from a commercial growout operation and were evenly distributed among five isolator floor pens and continued on feed with monensin for 3 wk. At 8 wk of age, the feed in pens was changed and given to turkeys for 16 d. At that time, the feed was changed so that the floor pens contained 1) no antimicrobial additives, 2) monensin as before, 3) virginiamycin, 4) Flavomycin, or 5) bacitracin.

[B]0 = 1 d before feed change; 1, 3, 7, 16 = 1, 3, 7, or 16 d after feed change, respectively. Overall mean = pooled mean for all sample Days 0 to 16.

[C]Enterobacteriaceae.

[a,b] For a given bacterial type, means within a column with different lowercase letters are significantly different ($P < 0.05$).

TABLE 3. Microbial counts of bacterial populations from the cecum of commercial turkeys after a change in antimicrobial feed treatment, Trial 2

BACTERIAL GROUP	ANTIMICROBIAL IN FEED AFTER CHANGE[A]	CONTENTS OF CECUM (mean $\log_{10}$ cfu/g ± SD)[B]					OVERALL MEAN[B]
		0	1	3	7	16	
Total aerobes	None	6.3 ± 0.6	5.8 ± 0.9	6.5 ± 0.6[a]	5.0 ± 1.0[ab]	6.1 ± 0.4	5.9
	Monensin	5.9 ± 0.8	6.3 ± 0.4	6.0 ± 0.6[ab]	5.7 ± 0.6[a]	6.0 ± 0.5	6.0
	Virginiamycin	6.0 ± 0.4	6.0 ± 1.0	6.6 ± 0.4[a]	4.3 ± 0.5[b]	6.5 ± 0.6	5.9
	Flavomycin	6.5 ± 1.0	5.7 ± 0.5	6.1 ± 0.6[ab]	4.4 ± 0.4[b]	6.4 ± 0.6	5.8
	Bacitracin	6.0 ± 0.7	6.2 ± 0.7	5.6 ± 0.2[b]	4.9 ± 0.5[ab]	6.1 ± 1.1	5.8
Enterics[C]	None	5.6 ± 0.8	5.6 ± 0.7	6.0 ± 0.4	4.9 ± 1.1	4.8 ± 0.8	5.4
	Monensin	5.8 ± 0.6	6.2 ± 0.3	5.7 ± 0.5	5.1 ± 0.6	4.5 ± 1.0	5.5
	Virginiamycin	5.7 ± 1.0	5.7 ± 1.0	5.9 ± 0.6	5.6 ± 0.6	4.5 ± 0.8	5.5
	Flavomycin	5.9 ± 1.3	5.2 ± 0.8	5.0 ± 1.0	5.8 ± 0.4	5.2 ± 0.6	5.4
	Bacitracin	6.6 ± 0.6	5.9 ± 0.6	5.0 ± 0.5	5.4 ± 0.6	5.0 ± 0.6	5.6
Lactobacilli	None	8.0 ± 1.3	7.5 ± 0.3	6.2 ± 0.5[ab]	6.1 ± 0.4	5.9 ± 0.6	6.7
	Monensin	7.3 ± 0.6	7.3 ± 0.3	6.3 ± 0.4[ab]	6.0 ± 1.1	6.1 ± 0.4	6.6
	Virginiamycin	7.1 ± 0.2	7.2 ± 0.6	6.4 ± 0.1[a]	6.4 ± 0.2	6.1 ± 0.4	6.6
	Flavomycin	6.8 ± 0.1	7.3 ± 0.3	6.1 ± 0.1[a]	6.3 ± 0.2	6.0 ± 0.5	6.5
	Bacitracin	7.3 ± 1.4	7.9 ± 0.6	5.6 ± 0.3[b]	6.2 ± 0.6	6.1 ± 0.5	6.6
Total anaerobes	None	9.6 ± 0.8	9.8 ± 0.3	8.6 ± 0.7[bc]	8.8 ± 1.1[ab]	9.6 ± 0.9	9.3
	Monensin	8.7 ± 0.8	10.0 ± 0.2	9.6 ± 0.1[a]	8.3 ± 0.5[b]	8.5 ± 0.6	9.0
	Virginiamycin	9.4 ± 0.5	10.2 ± 0.5	9.6 ± 0.9[ab]	9.4 ± 0.3[a]	9.3 ± 0.4	9.6
	Flavomycin	9.4 ± 0.8	9.7 ± 0.3	9.1 ± 1.4[ab]	9.3 ± 0.4[a]	8.4 ± 0.4	9.2
	Bacitracin	8.8 ± 0.6	9.6 ± 0.2	7.6 ± 0.7[c]	9.6 ± 0.7[a]	8.7 ± 1.2	8.9
Clostridia	None	6.6 ± 0.8	8.6 ± 0.5	6.8 ± 0.2	6.6 ± 0.8[ab]	6.2 ± 0.4	7.0
	Monensin	7.3 ± 1.1	8.9 ± 0.8	6.4 ± 1.1	6.9 ± 1.1[ab]	6.1 ± 0.2	7.1
	Virginiamycin	7.5 ± 0.8	8.0 ± 0.5	7.2 ± 1.7	7.6 ± 0.8[a]	6.0 ± 0.9	7.3
	Flavomycin	6.3 ± 0.2	8.3 ± 0.5	6.4 ± 1.0	5.9 ± 0.6[b]	5.9 ± 0.6	6.6
	Bacitracin	6.6 ± 0.4	8.5 ± 0.6	5.2 ± 0.4	6.5 ± 0.6[ab]	5.6 ± 0.8	6.5

[A]Turkeys that were 5 wk old and on feed with monensin (anticoccidial) were obtained from a commercial growout operation and were evenly distributed among five isolator floor pens and continued on feed with monensin for 3 wk. At 8 wk of age, the feed in pens was changed and given to turkeys for 16 d. At that time, the feed was changed so that the floor pens contained 1) no antimicrobial additives, 2) monensin as before, 3) virginiamycin, 4) Flavomycin, or 5) bacitracin.
[B]0 = 1 d before feed change; 1, 3, 7, 16 = 1, 3, 7, or 16 d after feed change. Overall mean = pooled mean for all sample Days 0 to 16.
[C]Enterobacteriaceae.
[a,b] For a given bacterial type, means within a column with different lowercase letters are significantly different ($P < 0.05$).

Conclusions and Applications

1. No major disruption of populations of autochthonous bacteria from the turkey intestinal tract was observed in the first 16 d following a change in feed from one containing the anticoccidial monensin to one containing a growth-promoting antibiotic.
2. Additional research is needed to determine whether the increase in the number of lactobacilli and clostridia in the intestinal tract of turkeys 80 to 90 d of age and 109 to 120 d of age as observed in the field trial is a reproducible event and, if so, whether it is related to use of or change in feed antimicrobials.
3. The effects on intestinal populations of bacteria of adding any one of the growth-promoting antibiotics (virginiamycin, Flavomycin, or bacitracin) were similar to the effects of adding either of the other two.

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